Brit. Heart J., 1965, 27, 763.

EXTERNAL CAROTID ARTERY APPROACH TO THE AORTA AND LEFT VENTRICLE IN CHILDREN

BY

M. J. GOLDBERG, R. W. PORTAL, AND J. N. PATTINSON

From the Departments of Cardiology and Radiology, The Middlesex Hospital, London W.1

Received February 15, 1965

The past two decades have seen the development of at least six methods of reaching one or other of the left heart chambers. (1) Retrograde entry into the left ventricle by catheterization of the ulnar artery was described by Zimmerman, Scott, and Becker in 1950, and use of radial, brachial, or femoral artery is now a familiar procedure, often performed by Seldinger's technique (1953) of percutaneous introduction of the catheter. (2) Left ventricular puncture, first reported as a systematic procedure by Ponsdomenech and Núñez (1951) and later by Brock, Milstein, and Ross (1956), forms a second approach. (3) There is the transbronchial route to the left atrium described by Facquet *et al.* (1952) and Allison and Linden (1953), and (4) the technique of posterior paravertebral puncture of the left atrium developed by Björk, Malmström, and Uggla (1953). (5) Radner in 1955 presented his experience of suprasternal puncture of aorta, pulmonary artery, and left atrium; and (6) finally came the introduction by Ross, Braunwald, and Morrow (1959) and by Cope (1959) of transseptal puncture by a needle passed to the right atrium from the saphenous or femoral vein, a technique that has even proved adaptable to an approach from above by the external jugular vein (Bevegård *et al.*, 1960).

Not all these approaches are suitable for children, but when catheterization of the aorta or left ventricle is required the retrograde approach by one of the limb arteries is among those most commonly employed. A large series of such investigations has been reported by Vlad, Hohn, and Lambert (1964). In such procedures the risk of damage to the vessel, with subsequent thrombosis, is ever present, and anxiety over the circulation to the limb can be disturbing to the operator. When an aortogram or left ventricular catheterization is needed it is an advantage to be able to employ a vessel which is known to be dispensable, and which can be sacrificed without hesitation at the end of the procedure. The external carotid artery, or one of its branches, meets these criteria, and it is the purpose of this communication to put forward this approach as a safe and useful one, which we have so far found free from complications.

Procedure and Results

The investigation is carried out under general anæsthesia, the right external carotid artery being used. A transverse incision is made in a skin crease beneath the angle of the jaw. The dissection of the external carotid is a relatively simple one for any surgeon familiar with the neck, and a number of our surgical colleagues have assisted. The facial or lingual branch of the artery is used where possible, and even in small babies we have often found these branches to be surprisingly large and well able to accept a number 6 catheter (N.I.H. side hole). If, however, the branches are too small or not readily accessible the external carotid itself is employed. When the vessel has been isolated controlling ligatures are placed proximal and distal to the point chosen for entry, which is opened

TABLE

DIAGNOSIS AND DETAILS OF PROCEDURES IN 12 CHILDREN UDERGOING EXTERNAL CAROTID CATHETERIZATION

Case No.	Age	Final diagnosis	Investigation
1	6 wk.	Coarctation of aorta	Aortogram
2	16 mth.	Coarctation of aorta; patent ductus arteriosus	Aortogram
3	2 mth.	Coarctation of aorta	Aortogram
4	3 mth.	Ventricular septal defect	Left ventriculogram intended; right ventriculogram performed owing to passage of catheter through VSD
5	4 yr.	Patent ductus arteriosus	Aortogram
6	3 yr.	Corrected transposition of great vessels; single ventricle	Aortogram
7	3½ yr.	Left ventricular-right atrial communication	Left ventriculogram
8	8 mth.	Congenital mitral incompetence; coarctation of aorta; patent ductus arteriosus	Left ventriculogram; aortogram
9	3 yr.	Corrected transposition; ventricular septal defect	Left ventriculogram
10	5½ yr.	Ventricular septal defect; atrial septal defect	Left ventriculogram
11	3 yr.	Cor triatriatum	Left ventriculogram
12	4 yr.	Hypertrophic obstructive cardiomyopathy	Left ventriculogram

with small scissors. At the end of the procedure the vessel is tied off, no attempt being made to repair it. The wound heals well and after a few months the scar is barely visible.

We first used this approach in 1961 and have resorted to it for purposes of angiocardiography in 12 children. The Table lists their ages, the final diagnosis, and the investigation performed. A

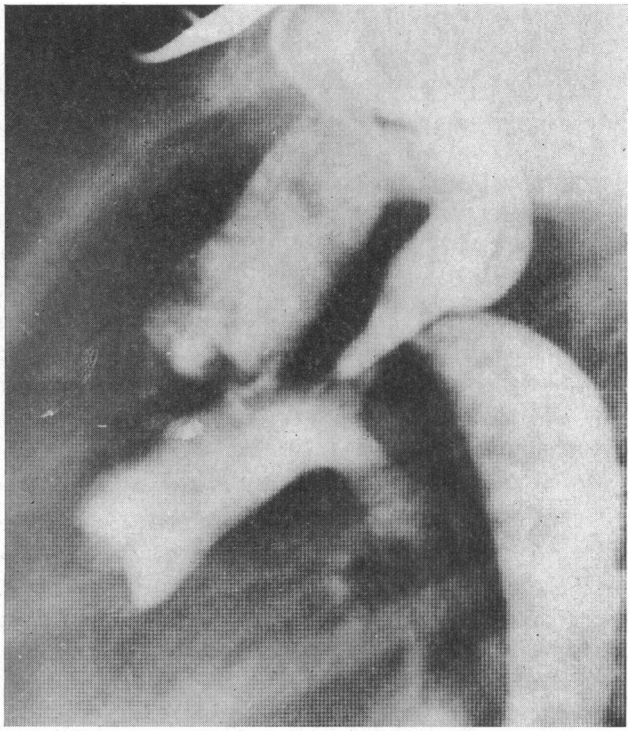


FIG. 1.—Case 2. Lateral view of thoracic aorta with injection into the distal aortic arch, showing coarctation and patent ductus arteriosus in baby aged 16 months.

total of 6 aortic and 7 ventricular injections has been made. Representative illustrations are shown in Fig. 1 to 4.

Discussion

A carotid approach to the aortic arch was described in 1949 by Jönsson, who introduced a cannula into the common carotid artery by percutaneous puncture and guided it to the arch. The technique was employed for aortography, but was recommended with caution and never gained popularity. Since then puncture of the carotid system has been reserved for visualization of the distal arterial tree, and reports of the use of a neck vessel for retrograde catheterization have not been forthcoming.

In infants and children three routes have found favour for entry to the left heart. Roveti, Ross, and Bahnson (1962) reported successful transseptal puncture in 85 per cent of 20 children aged 18 months to 6 years, with entry of the left ventricle in 70 per cent. Brockenbrough and colleagues (1962) were successful by this route in 63 out of 65 children under 16. They also employed left ventricular puncture, and obtained satisfactory tracings in no less than 45 out of 46 subjects. It was their opinion that only these two routes were suitable for routine use in small children, and they did not favour a retrograde approach. Vlad and colleagues (1964), however, in their large experience of left heart catheterization in 500 infants and children apparently employed the retrograde method exclusively. By catheterizing the brachial or superficial femoral arteries they were able to enter the left ventricle in 92 per cent of cases. Though they observed diminution or loss of peripheral pulses in about one-third of the subjects, serious vascular insufficiency was seen only once. Damage to peripheral arteries occasionally occurs and is always a worrying development; the management of such injuries has been discussed by Bell (1962).

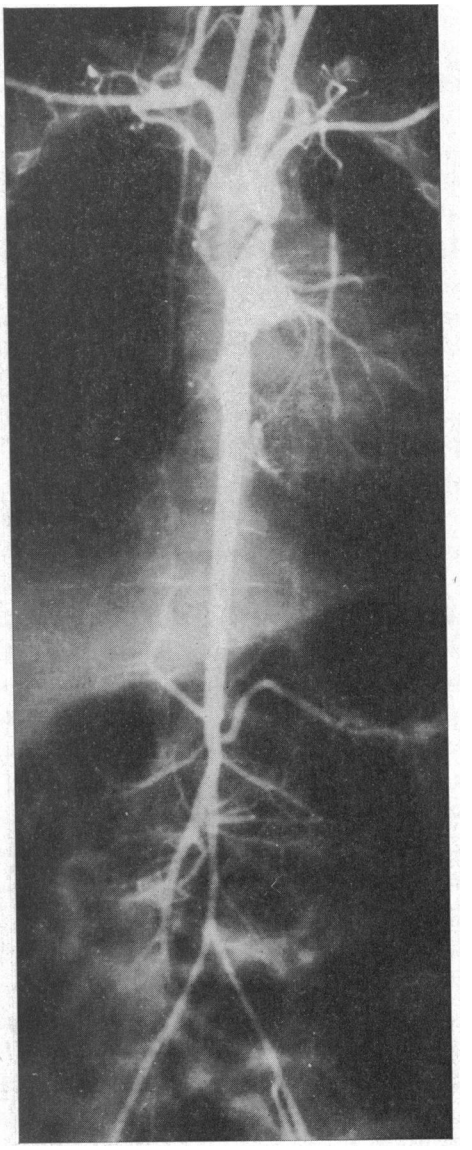
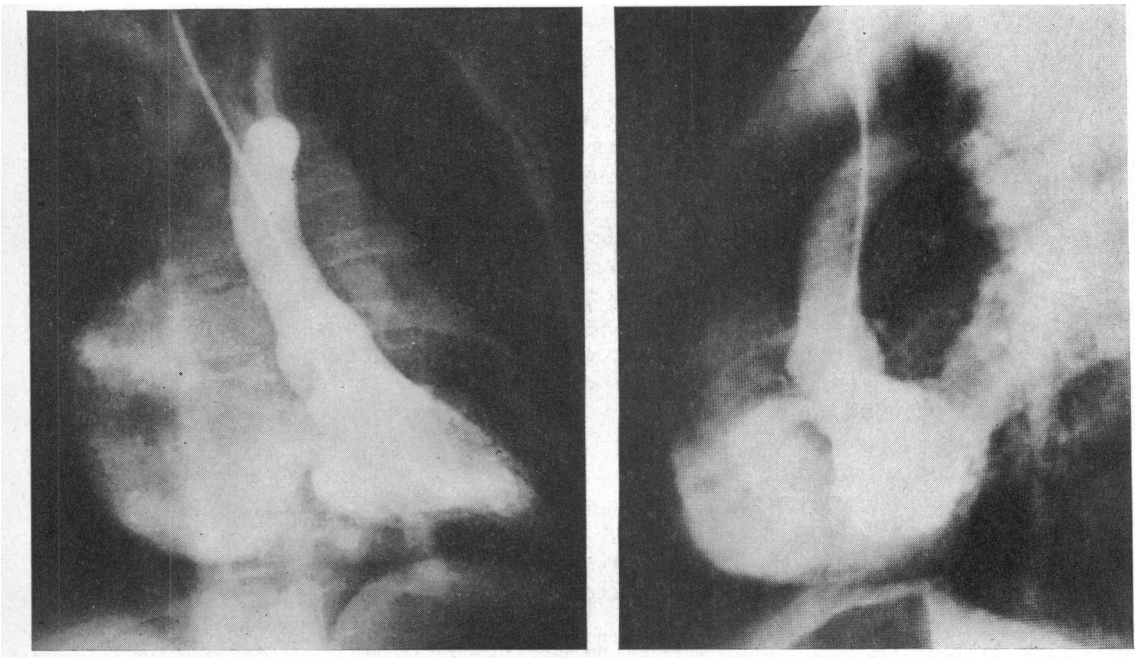


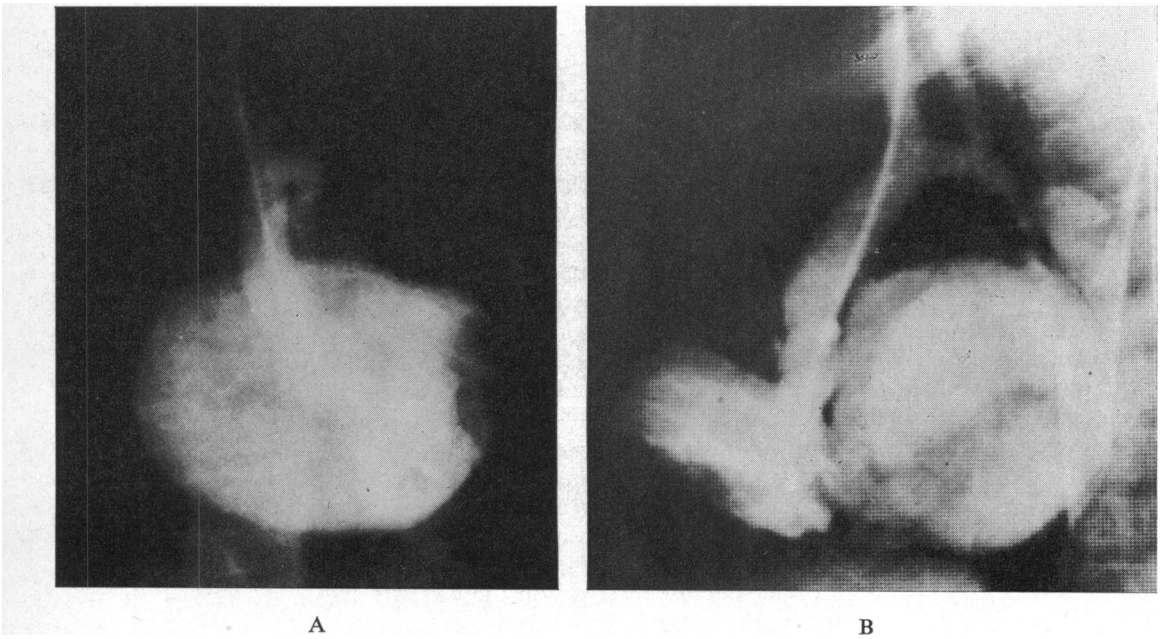
Fig. 2.—Case 3. Antero-posterior view of aortic injection, showing coarctation in a baby aged 2 months. The abdominal aorta beyond the cœliac axis is very narrow.

Our practice is to use the external carotid approach in infants and small children (under 5 or 6 years), and a limb artery in older children. Apart from the avoidance of thrombotic sequelæ there are other advantages in this route. The first is the ease with which the catheter, once introduced, can be passed to the aortic valve and into the ventricle. In attempting to enter the ventricle from a limb vessel, difficulty may be encountered in negotiating the aortic arch or in passing the aortic orifice; when using the carotid approach the distance to the valve is less and the route almost straight, so that manipulation is much easier. Furthermore, little or no bend on the catheter is required and the straight catheter tip is therefore readily directed at the valve orifice. The size of the vessel allows the introduction of a large catheter, which is important from the point of view of angiography, the quality of which has in our experience been very satisfactory. Finally, vasospasm has never been a problem in the relatively short carotid trunk.



A B

FIG. 3.—Case 7. Left ventricular injection in a 3½-year-old child, showing passage of contrast medium through a ventricular septal defect into the right atrium. (A) Antero-posterior view; (B) lateral view.



A B

FIG. 4.—Case 8. Left ventricular injection in a baby aged 8 months. There is gross incompetence through a congenitally deformed mitral valve. An aortic coarctation had been resected and a patent ductus ligated 6 months earlier, and a residual stricture at the coarctation site is demonstrated. (A) Antero-posterior view; (B) lateral view.

SUMMARY

Catheterization of the external carotid artery as an approach to the aorta or left ventricle has been employed on 12 occasions in infants and small children. The use of this vessel or one of its branches for a retrograde approach to the left ventricle, instead of the brachial or femoral artery, avoids the risk of impairing the circulation to a limb, and allows a large catheter to be inserted closer to the valve, with greater ease of manipulation. No complications have occurred. The technique is put forward as a useful and safe route to aorta and left ventricle in patients of this age-group.

We are grateful to Dr. R. J. K. Brown, Dr. E. W. Hart, and Dr. Walter Somerville for permission to report these cases, and we thank our four surgical colleagues who assisted with the carotid dissections.

REFERENCES

Allison, P. R., and Linden, R. J. (1953). The bronchoscopic measurement of left auricular pressure. *Circulation*, **7**, 669.

Bell, J. W. (1962). Treatment of post-catheterization arterial injuries. *Ann. Surg.*, **155**, 591.

Bevegård, S., Carlens, E., Jönsson, B., and Karlöf, I. (1960). A technique for transeptal left heart catheterization via the right external jugular vein. *Thorax*, **15**, 299.

Björk, V. O., Malmström, G., and Uggla, L. G. (1953). Left auricular pressure measurements in man. *Ann. Surg.*, **138**, 718.

Brock, R., Milstein, B. B., and Ross, D. N. (1956). Percutaneous left ventricular puncture in the assessment of aortic stenosis. *Thorax*, **11**, 163.

Brockenbrough, E. C., Braunwald, E., Ross, J., and Morrow, A. G. (1962). Left heart catheterization in infants and children. *Pediatrics*, **30**, 253.

Cope, C. (1959). Technique for transseptal catheterization of the left atrium: preliminary report. *J. thorac. Surg.*, **37**, 482.

Facquet, J., Lemoine, J. M., Alhomme, P., and Lefebvre, J. (1952). La mesure de la pression auriculaire gauche par voie transbronchique. *Arch. Mal. Cœur*, **45**, 741.

Jönsson, G. (1949). Thoracic aortography by means of a cannula inserted percutaneously into the common carotid artery. *Acta radiol. (Stockh.)*, **31**, 376.

Ponsdomenech, E. R., and Núñez, V. B. (1951). Heart puncture in man for diodrast visualization of the ventricular chambers and great arteries. *Amer. Heart J.*, **41**, 643.

Radner, S. (1955). Extended suprasternal puncture technique. *Acta med. scand.*, **151**, 223.

Ross, J., Braunwald, E., and Morrow, A. G. (1959). Transseptal left atrial puncture. New technique for the measurement of left atrial pressure in man. *Amer. J. Cardiol.*, **3**, 653.

Roveti, G. C., Ross, R. S., and Bahnson, H. T. (1962). Transseptal left heart catheterization in the pediatric age group. *J. Pediat.*, **61**, 855.

Seldinger, S. I. (1953). Catheter replacement of the needle in percutaneous arteriography. A new technique. *Acta radiol. (Stockh.)*, **39**, 368.

Vlad, P., Hohn, A., and Lambert, E. C. (1964). Retrograde catheterization of the left heart. Experience with 500 infants and children. *Circulation*, **29**, 787.

Zimmermann, H. A., Scott, R. W., and Becker, N. O. (1950). Catheterization of the left side of the heart in man. *Circulation*, **1**, 357.